Great Basin Naturalist 54(4), © 1994, pp. 329–334

HABITAT PREFERENCE AND DIURNAL USE AMONG GREATER SANDHILL CRANES

Donald E. McIvor[1] and Michael R. Conover[1]

ABSTRACT.—We examined patterns of habitat use by Greater Sandhill Cranes (*Grus canadensis tabida*) in the Intermountain West, April–October 1991–92, to determine whether cranes exhibited a specific preference for crops, fields, and areas within a field. This information will help farmers and wildlife managers direct nonlethal control methods to the sites where crane damage is most likely to occur. We conducted surveys along two 37-km transects weekly in Cache Valley, Utah, and biweekly in Bear River Valley, Rich County, Utah, and Lincoln County, Wyoming. We recorded 5814 cranes in 662 separate groups. Most were located in pasture/hay (34%), small grain (39%), alfalfa (9%), plowed (9%), fallow (4%), or corn (1%) fields. An index of feeding activity for each field and habitat type suggested cranes fed at approximately the same rate in each field and habitat type. Crane diurnal activity patterns during summer and fall revealed that grainfields were used heavily throughout the day.

Key words: Greater Sandhill Cranes, Grus canadensis tabida, *habitat, depredation, diurnal activity, Utah, Wyoming.*

The most recent population estimate for the Rocky Mountain Greater Sandhill Crane is 17,000–20,000 (Drewien et al. 1987:27). Records of local summer populations are less complete, but the crane population in Cache Valley, Utah, has increased from 14 individuals in 1970 (Drewien and Bizeau 1974) to approximately 200 in 1990 (Bridgerland Audubon Society 1990). Between 1985 and 1987, Rowland et al. (1992) reported 255 cranes summering in Lower Bear River Valley, Wyoming.

Crop depredation complaints attributed to cranes are rising concomitantly with population numbers (Lockman et al. 1987). In response to depredation complaints, Wyoming instituted a limited Sandhill Crane hunt in 1982. Utah instituted a hunt in 1989, but the decision generated enough public controversy that the hunt was canceled in 1992.

Cranes are omnivorous (Mullins and Bizeau 1978) and readily feed in agricultural lands, although habitat use seems to vary widely. Agricultural fields comprised 91% of habitat used by wintering cranes in western Texas (Iverson et al. 1985). During spring staging in Nebraska, Krapu et al. (1984) reported that 70% of habitat use was in agricultural lands. Within agricultural fields 99% of use was in corn stubble. Approximately 80% of spring diurnal habitat use in Alaska was in barley (Iverson et al. 1987). In Wyoming crane use of wet meadows and grainfields ranged from 69 to 100% (Rowland et al. 1992).

We examined habitat preferences and foraging habits of summer resident Sandhill Cranes because of increasing depredation complaints from farmers growing corn and small grains (e.g., barley, oats, rye, wheat) in Cache and Rich counties, Utah. As one means of evaluating these problems and potential solutions, we tested the hypothesis that crane use was concentrated in corn and small-grain fields in particular and in agricultural fields in general. High use of a field may alarm a farmer, but little damage may occur if birds are not foraging. Hence, we also tested the hypothesis that cranes forage in habitats in proportion to their availability. In addition, we assessed whether habitat use varied diurnally during summer and fall. Additional questions relevant to selecting an appropriate scale for management include (1) whether cranes use all fields available to them or concentrate their activities in a few fields, and (2) how cranes distribute their activities within fields.

METHODS

The study area is in Cache Valley, Utah, and Bear River Valley, Utah and Wyoming, and includes three contiguous counties: Cache and Rich counties in northern Utah and Lincoln

[1]Department of Fisheries and Wildlife, Utah State University, Logan, Utah 84322.

County in southwestern Wyoming. A comprehensive description of the area is included in McIvor and Conover (1992). Cranes normally occupy the region from April until early October.

To determine patterns of field use, we established a 37-km transect in Cache Valley and another in Bear River Valley. The transects traversed a sample of habitat types available to cranes, including cultivated fields, pastures, and natural habitats. Sampling was conducted based on a visual survey method similar to that used by Iverson et al. (1985, 1987). Transects were surveyed weekly in Cache Valley and biweekly in Bear River Valley from April through mid-October 1991–92.

Surveys began 2 h after sunrise from a vehicle moving at 40 km/h. Habitats on both sides of the transects were scanned systematically. As cranes were located, a variety of parameters, including type of habitat in use, were recorded. Habitat was categorized by crop (alfalfa, corn, small grain, pasture, hay, or mixed use) or groundcover type (riparian, sage [*Artemisia* spp.] scrub). To examine the distribution of cranes within fields, we recorded the distance between field edge and the individual crane closest to the edge using a range finder. These data produced a distance-to-edge estimate, which we used as a general indication of whether cranes preferentially used edges or interiors of fields. Using the range finder, we also recorded minimum distance from the transect to the crane flock.

Each sighting of cranes was given equal weighting in constructing contingency tables to maintain statistical independence among field-use observations. A few observations of cranes were made in mixed-use fields and on rural roads. These sightings were combined under the miscellaneous category. Early season hayfields were difficult to distinguish from pastures, and these observations were pooled.

Habitat availability was quantified along each transect in July 1991 and 1992. A sample of 125 random points on each transect was selected *a priori*, and each point was located and its habitat type recorded. To be selected as representative of habitat, each point had to meet two criteria. First, any sampling point not visible from the transect was not used. Second, the perpendicular distance from transect to sampled habitat locations was bounded by the distance within which 90% of all cranes had been located during weekly surveys.

An index of feeding activity was developed to allow comparison among habitat types. When ≥ 1 crane was sighted, an individual was chosen at random from the flock and observed for 1 min to determine if the bird was feeding. The result was a logical variable (feed/no feed), and these data were compiled and compared across habitat types.

Quantitative analyses were based on methods devised by Neu et al. (1974). We used a goodness-of-fit test ($P < .05$) to examine the hypothesis that cranes used habitats in proportion to habitat availability, and to determine whether cranes fed preferentially in certain habitat types. We used a Bonferroni Z-statistic to test for habitat and feeding preference. The Z-statistic and resulting family confidence interval for testing each contingency table cell were generated using a Monte Carlo sampling simulation from a binomial distribution, on a mainframe computer using Minitab (1989).

In 1992 we mapped the distribution of grain- and cornfields along the survey transects. We then compared distribution of available fields with the frequency distribution of cranes observed to test the H_0 of equal use among all grain- and cornfields. These data were analyzed using a goodness-of-fit test.

Patterns of diurnal habitat use were recorded over a 5-d period in June 1991 using both transects and during September 1992 using only the Cache Valley transect. Data-collection methods were identical to those used in the habitat-use survey described above, except that transects were sampled 5 times/day: sunrise, 2 h after sunrise, noon, 4 h before sunset, and 2 h before sunset.

We used PC-SAS (SAS Institute, Inc. 1988) and the PROC CATMOD routine to examine June 1991 diurnal-use data, and the PROC FREQ routine to examine September 1992 data. Both SAS routines used a goodness-of-fit test ($P < .05$) to examine the null hypothesis that cranes maintained the same pattern of field use throughout the day.

RESULTS

Fifty-three surveys were conducted in Cache Valley and 29 in Bear River Valley. During two field seasons we recorded 5814 cranes in 662 groups. Most groups were observed in pasture/hay (34%), small grains (39%), alfalfa (9%), plowed fields (9%), fallow (4%), or cornfields (1%). Remaining cranes were located in riparian (3%), sagebrush (1%), and miscellaneous (2%) habitats.

Habitat availability differed between the two survey transects (Table 1). Although the Cache Valley transect contained no sagebrush habitat, the Bear River Valley transect contained extensive sagebrush (61% in 1991, 58% in 1992). Conversely, the Cache Valley transect contained a small amount of corn (7%) in 1991–92, a crop not cultivated in Bear River Valley. Analysis indicated variation in habitat availability between years along each transect, although the change was not statistically significant (P = .2230). For these reasons, collapsing the contingency tables across sample sites or across years would have made the results ambiguous.

Cranes were not distributed randomly among nine available habitats in either 1991 (X^2 = 374.0, df = 13, P < .005) or 1992 (X^2 = 464.1, df = 14, P < .005). Along the Cache Valley transect, cranes avoided alfalfa and

TABLE 1. Habitat availability, use, and selection among Sandhill Cranes in Cache Valley (C), Utah, and Bear River Valley (B), Utah and Wyoming, in 1991 and 1992.

Habitat	Study area	# crane observations	Expected # crane observations	Proportion of study area (p_{i0})	Proportion observed in each area	95% family confidence interval on (p_i)	Use preference[a]
1991							
Alfalfa	C	6	25	0.130	0.031	$.0 \le p_i \le .067$	–
	B	14	12	0.158	0.182	$.065 \le p_i \le .325$	0
Corn	C	6	13	0.065	0.031	$.0 \le p_i \le .067$	0
	B	0	0	0.0	0.0	nt[b]	nt[b]
Fallow	C	1	4	0.023	0.005	$.0 \le p_i \le .021$	–
	B	0	0	0.0	0.0	nt[b]	nt[b]
Grain	C	60	34	0.174	0.308	$.205 \le p_i \le .405$	+
	B	18	7	0.096	0.234	$.104 \le p_i \le .364$	+
Misc.	C	4	30	0.152	0.021	$.0 \le p_i \le .051$	–
	B	1	3	0.044	0.013	$.0 \le p_i \le .065$	0
Pasture	C	87	70	0.359	0.446	$.346 \le p_i \le .544$	0
	B	35	5	0.070	0.455	$.299 \le p_i \le .610$	+
Plowed	C	22	6	0.033	0.113	$.051 \le p_i \le .174$	+
	B	1	1	0.009	0.013	$.0 \le p_i \le .065$	0
Riparian	C	10	13	0.065	0.051	$.010 \le p_i \le .097$	0
	B	6	1	0.009	0.078	$.013 \le p_i \le .169$	+
Sage	C	0	0	0	0	nt[b]	nt[b]
	B	2	47	0.614	0.026	$.0 \le p_i \le .091$	–
1992							
Alfalfa	C	29	61	0.194	0.092	$.051 \le p_i \le .153$	–
	B	9	9	0.121	0.123	$.027 \le p_i \le .246$	0
Corn	C	2	20	0.0065	0.006	$.0 \le p_i \le .022$	–
	B	0	0	0.0	0.0	nt[b]	nt[b]
Fallow	C	20	24	0.075	0.064	$.025 \le p_i \le .102$	0
	B	3	1	0.010	0.041	$.0 \le p_i \le .123$	0
Grain	C	144	57	0.183	0.459	$.382 \le p_i \le .535$	+
	B	32	4	0.061	0.438	$.274 \le p_i \le .616$	+
Misc.	C	7	34	0.108	0.022	$.003 \le p_i \le .051$	–
	B	0	1	0.020	0.0	nt[b]	nt[b]
Pasture	C	78	84	0.269	0.248	$.172 \le p_i \le .322$	0
	B	25	11	0.152	0.342	$.192 \le p_i \le .507$	+
Plowed	C	28	14	0.043	0.089	$.051 \le p_i \le .134$	+
	B	5	1	0.010	0.068	$.0 \le p_i \le .164$	0
Riparian	C	6	20	0.065	0.019	$.003 \le p_i \le .048$	–
	B	1	4	0.051	0.014	$.0 \le p_i \le .068$	0
Sage	C	0	0	0.0	0.0	nt[b]	nt[b]
	B	2	42	0.576	0.027	$.0 \le p_i \le .096$	–

[a]Habitat use is expressed as selection for (+), use in proportion to availability (0), and avoidance (–).
[b]Not tested; this habitat type was not recorded in the study area.

miscellaneous habitats in both years, selected grain and plowed habitats in excess of their availability, and used pasture in proportion to its availability. Along the Bear River transect, cranes avoided sagebrush habitat, selected grain and pasture habitats, and used alfalfa and plowed habitat types in proportion to their availability. Results from other habitat types along the two transects either varied between years or were not tested due to patterns of sampling or structural zeros in the contingency tables.

We examined distribution of cranes using grain- and cornfields in 1992 and found that certain grainfields received preferential use in Cache Valley ($X^2 = 272.4$, df = 72, $P < .001$) and in Bear River Valley ($X^2 = 42.6$, df = 10, $P < .001$). Insufficient data were available for cornfields in 1992. Cranes tended to exploit field interiors but were broadly distributed within fields. In 1991–92 mean distance-to-field-edge for flocks in corn was 82.2 m (n = 7, SE = 21.2) and 72.1 m (n = 250, SE = 7.26) for flocks using grainfields.

Cranes were recorded feeding in 75% of our observations. A goodness-of-fit test was used to examine the distribution of cranes feeding in each habitat type in comparison to habitat availability (Table 2). Feeding cranes were not distributed randomly in 1991 ($X^2 = 242.8$, df = 13, $P < .0005$) or 1992 ($X^2 = 332.4$, df = 14, $P < .0005$). Distribution of feeding cranes approximated distribution of all cranes observed, except in the case of riparian habitat along the Bear River transect. While cranes used this habitat type disproportionately to its availability in 1991, they appeared to feed in this habitat type in proportion to its availability. Data for 1992 were insufficient for analysis.

Crane diurnal use of field types varied with time of day (summer diurnal sampling: $X^2 = 91.04$, df = 48, $P = .0002$; fall diurnal sampling: $X^2 = 72.65$, df = 24, $P < .01$). Crane numbers peaked after sunrise, decreased steadily throughout the day, and then increased again before sunset.

DISCUSSION

Crop depredation attributed to cranes was reported by farmers in Cache, Rich, and Lincoln counties (McIvor 1993). Crane damage occurred in spring in the Cache Valley transect, primarily with newly planted corn crops. Cranes pulled up corn plants and consumed the still-attached seed. Farmers also reported minor damage from cranes trampling emergent alfalfa and small grains (winter wheat, barley, oats). The growing season along the Bear River transect in Rich and Lincoln counties is too short for corn production, and crop damage occurred primarily in the fall, affecting small-grain crops (Lockman et al. 1987, McIvor and Conover 1994). Some trampling damage in spring was also reported in this area.

Cranes concentrated activities in small-grain fields during our surveys. Fields planted in corn constituted only 7% of available habitat, and <3% of cranes sighted were in corn. Most activity in cornfields occurred during germination or while plants were young. Thereafter, cranes avoided cornfields until harvest.

Large expanses of sagebrush habitat were little used, although they constituted about 60% of available habitat. Sagebrush habitat may have reduced crane foraging efficiency by creating dense cover, limiting movement, and offering few plant foods. Agricultural fields in Bear River Valley were surrounded by vast expanses of sagebrush, a condition that may have concentrated cranes into agricultural fields.

Feeding activity closely approximated patterns of habitat use, suggesting cranes fed with the same intensity in each habitat type. Migrating cranes in Nebraska relied on a diversity of habitats to provide various components of their diet (Reinecke and Krapu 1986). Alfalfa fields (Walker and Schemnitz 1987) and grasslands (Reinecke and Krapu 1986) provided a source of invertebrates for cranes. Although invertebrates may provide certain proteins absent from plant foods (Reinecke and Krapu 1986), they comprise only a small component of the diet, varying from 3% (Reinecke and Krapu 1986) to 27% (Mullins and Bizeau 1978). In this study cranes appeared to avoid feeding in Cache Valley alfalfa fields, possibly obtaining invertebrates from pastures or plowed fields. In Bear River Valley cranes fed actively in pasture.

Corn (Reinecke and Krapu 1986) and cereal grains (Krapu and Johnson 1990) provide important nutrient sources for fat synthesis in cranes. Habitat use and feeding activity in grainfields, along both transects and in both

TABLE 2. Distribution of Sandhill Cranes observed feeding in various habitat types in Cache Valley (C), Utah, and Bear River Valley (B), Utah and Wyoming, in 1991 and 1992.

Habitat	Study area	# crane observations	Expected # crane observations	Proportion of study area (p_{i0})	Proportion observed in each area	95% family confidence interval on (p_i)	Use preference[a]
1991							
Alfalfa	C	5	17	0.130	0.037	.0 ≤ p_i ≤ .090	–
	B	11	9	0.158	0.186	.068 ≤ p_i ≤ .356	0
Corn	C	4	9	0.065	0.030	.0 ≤ p_i ≤ .075	0
	B	0	0	0.0	0.0	nt[b]	nt[b]
Fallow	C	0	3	0.023	0	nt[b]	nt[b]
	B	0	0	0.0	0.0	nt[b]	nt[b]
Grain	C	44	23	0.174	0.328	.209 ≤ p_i ≤ .440	+
	B	14	6	0.096	0.237	.102 ≤ p_i ≤ .407	+
Misc.	C	2	20	0.152	0.015	.0 ≤ p_i ≤ .045	–
	B	1	3	0.044	0.017	.0 ≤ p_i ≤ .068	0
Pasture	C	57	48	0.359	0.425	.313 ≤ p_i ≤ .560	0
	B	27	4	0.070	0.458	.271 ≤ p_i ≤ .644	+
Plowed	C	18	4	0.033	0.134	.052 ≤ p_i ≤ .239	+
	B	1	1	0.009	0.017	.0 ≤ p_i ≤ .082	0
Riparian	C	4	9	0.065	0.030	.0 ≤ p_i ≤ .075	0
	B	4	1	0.009	0.068	.0 ≤ p_i ≤ .169	0
Sage	C	0	0	0.0	0.0	nt[b]	nt[b]
	B	1	36	0.614	0.017	.0 ≤ p_i ≤ .085	–
1992							
Alfalfa	C	20	43	0.194	0.091	.041 ≤ p_i ≤ .155	–
	B	7	6	0.121	0.149	.021 ≤ v ≤ .319	0
Corn	C	1	14	0.065	0.005	.0 ≤ p_i ≤ .023	–
	B	0	0	0.0	0.0	nt[b]	nt[b]
Fallow	C	13	17	0.075	0.059	.023 ≤ p_i ≤ .100	0
	B	1	1	0.010	0.021	.0 ≤ p_i ≤ .085	0
Grain	C	106	40	0.183	0.482	.391 ≤ p_i ≤ .577	+
	B	19	3	0.061	0.404	.213 ≤ p_i ≤ .617	+
Misc.	C	2	24	0.108	0.009	.0 ≤ p_i ≤ .032	–
	B	0	1	0.020	0.0	nt[c]	nt[c]
Pasture	C	54	59	0.269	0.245	.173 ≤ p_i ≤ .327	0
	B	15	7	0.152	0.319	.170 ≤ p_i ≤ .532	+
Plowed	C	22	9	0.043	0.100	.050 ≤ p_i ≤ .164	+
	B	4	1	0.010	0.085	.0 ≤ p_i ≤ .234	0
Riparian	C	2	14	0.065	0.009	.0 ≤ p_i ≤ .032	–
	B	0	2	0.051	0.0	nt[c]	nt[c]
Sage	C	0	0	0.0	0.0	nt[b]	nt[b]
	B	1	27	0.576	0.021	.0 ≤ p_i ≤ .085	–

[a]Habitat use is expressed as selection for (+), use in proportion to availability (0), and avoidance (–).
[b]Not tested; this habitat type was not recorded in the study area.
[c]Not tested; insufficient observed frequencies to test hypothesis.

years, were greater than expected. Although midseason grainfields are unlikely to provide dietary components other than invertebrates, cranes probably forage for waste grain in spring stubble and for ripening and waste grain before and after fall harvest.

Certain grainfields, and possibly certain cornfields, are more attractive than others to cranes. Any burden imposed on the agricultural community by crane depredation is not shared evenly by producers. Determining why certain fields are more attractive to cranes and lessening these attractants may help reduce crane problems. Iverson et al. (1987:456) reported that "over 90% of the variation in distribution of staging cranes [in Nebraska] could be explained by the composition and juxtaposition of essential habitat types." Certain fields in our study area may receive chronic use because of their proximity to other habitat types, such as wetlands and roost sites, or because they possess characteristics that enhance predator detection and escape.

It is unlikely that crane presence has a significant negative effect on productivity of pasture, hay, and alfalfa fields. However, the concentration of cranes in small-grain fields, particularly in the fall, poses a potential economic threat to farmers. Delayed harvest of grains in fall due to wet weather is likely to exacerbate the problem because standing grain remains available to an increasing number of prestaging cranes (Lockman et al. 1987).

Diurnal changes in habitat use may allow cranes to forage while minimizing heat stress. Cranes using pasture and hayfields in midafternoon were probably loafing before feeding prior to sunset. For reasons that are unclear, activity patterns observed in Cache Valley were less distinct in Bear River Valley. Cranes may have moved less, visiting fewer habitat types as a result of the pattern of habitat distribution in Bear River Valley. Additionally, the Bear River Valley survey may have included a greater proportion of paired individuals, which remained on territories during early summer (Johnsgard 1991) and subsequently visited fewer habitat types.

Crane depredation occurs under two disparate conditions: in association with spring planting of corn and just before fall harvest of cereal grains. Encouraging rapid germination of corn and early harvest of grains would minimize availability of these resources to cranes during periods of susceptibility to depredation. Crane damage was concentrated in a few fields, rather than being evenly distributed in all fields, indicating that nonlethal techniques to alleviate these problems need to be focused in these same fields. Farmers who experience chronic depredation problems may wish to consider the economic feasibility of producing crops less prone to crane damage.

ACKNOWLEDGMENTS

Project funding was provided by the Utah State University Wildlife Damage Management Program and the Utah Division of Wildlife Resources. We thank D. A. Brink, K. V. Dustin, and H. Low for field assistance. R. S. Krannich, J. A. Bissonette, and P. M. Meyers provided helpful manuscript reviews, and S. L. Durham gave invaluable assistance with matters statistical.

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Received 2 September 1993
Accepted 20 April 1994